

INTUMESCENT REFLECTIVE COATING

DESCRIPTION

Field of the Invention

[0001] The present invention relates to a building materials top coating composition, and more particularly to a top coating composition for roofing products that provides durable exterior protection, and has intumescent and reflective properties.

Background of the Invention

[0002] Intumescent materials have been known for many years and have been employed as coatings that are capable of providing thermal protection up to approximately 650°C. Substrates such as wood, various metals including, for example, steel, iron, and aluminum, and various plastics such as polyvinyl chloride (PVC), thermoplastics and epoxies have been coated with an intumescent agent to make the substrates more fire-retardant.

[0003] In cases in which the intumescent coating is subjected to severe physical and environmental conditions, the application of the coating to one of the aforementioned substrates is impractical. In addition, with the increased use of wood and wood by-products and the proliferation of new types of wood composites for use in building construction applications, and composites of plastics and other organic materials, current intumescent fire-retardant coating compositions do not provide adequate protection from fire and heat for a prolonged time period.

[0004] Currently, there is no single intumescent fire-retardant coating that is capable of: (I) reducing the available oxygen in confined areas, such as a room, to smother the fire and to retard the fire in the advent of a flashover; (II) providing a low rate of thermal transmission for coatings to protect various substrates, especially where low

weight and low cost are critical; (III) providing an effective intumescent fire-retardant coating for roofing products which require zero flame spread for prolonged time exposure during a fire; (IV) providing sufficient mechanical properties and durability, to resist abrasion, impact and severe weather; (V) being non-toxic before it is exposed to heat, and the combustion products emitted upon exposure to heat, are below the gas level emissions required by today's transportation standards; and (VI) providing a coated roofing product that has an initial solar reflectance and a maintained solar reflectance that meets today's Energy Star® criteria.

[0005] Also, in many applications of an intumescent fire-retardant coating to a substrate, the intumescent coatings are impractical for reasons other than fire protection, as they lack abrasion resistance, impact resistance, water resistance, and resistance to other environmental factors. Because of these factors, present coatings do not provide protection from fire and heat for a sufficient time duration during a fire, and are not durable enough to last sufficiently long to make them cost effective.

[0006] One commonly employed intumescent agent for use in the building materials industry is hydrated alkali metal silicates. Under high temperatures that exist during a fire, the water of hydration is driven off causing the composition to expand by up to 20 to 40 times its original volume. Thus, when combined with fire-stop materials these silicates intumesce to provide a layer of insulation against fire and smoke.

[0007] Alkali metal silicates can also be incorporated into roofing materials such as asphalt shingles in order to convert these shingles into a fire retardant Class A or B form. Alkali metal silicate particles may be placed in an asphalt layer in between the top layer of asphalt and roofing granules and the substrate of organic felt or fiberglass mat. In the event of a fire on a roof, the intumescent silicate particles expand to form a thermal barrier which retards ignition of the roofing deck.

[0008] Despite their ongoing use in building material products, prior art coatings containing alkali metal silicates cannot provide a coating that satisfies the features mentioned above. Hence, there is a need for new and improved coating compositions that meet the above criteria. In particular, a coating composition for use in building products, particularly roofing products, is needed that is durable, intumescent (even after long exposure to moisture) and reflective (meeting today's Energy Star® criteria).

Summary of the Invention

[0009] The present invention provides a top coating composition for use in building material products such as roofing products that provides durable exterior protection to the surface to which it is applied as well as superior fire resistance and reflectivity. The reflectivity provided by the inventive top coating composition, which is dependent on the degree of sloping of the roofing surfaces, meets today's Energy Star® standards.

[0010] For low-sloped roofing products having surfaces with a slope of 2:12 inches or less as measured by ASTM Standard E 1918-97, the top coat of the present invention has an energy efficiency, as measured by its initial solar reflectance, greater than or equal to 0.65, and it maintains a solar reflectance for three years after installation under normal conditions of greater than or equal to 0.50 (measured after the first year). Low-slope roofing products are typically installed on low-sloped surfaces such as single ply membranes, built-up roofing (BUR), modified bitumen, and standing-seam profile metal roofing.

[0011] For steep-sloped roofing products having surfaces with a slope of greater than 2:12 inches, the top coat of the present invention has an energy efficiency, as measured by its initial solar reflectance, greater than or equal to 0.25, and it maintains a solar reflectance for three years after installation under normal conditions of greater than or equal to 0.15 (measured after the first year). Steep-sloped roofing products are typically installed on steep-sloped surfaces such as composite shingles, clay, concrete, fiber

cement tile, slate, shakes, architectural profiled metal and individual roofing components.

[0012] As indicated above, the energy efficiency of the top coat is determined by its solar reflectance. Solar reflectance by definition is the fraction of solar flux reflected by a surface expressed as a percent or within the range of 0.00 and 1.00.

[0013] The top coating composition of the present invention comprises a mixture of a polymeric binder, heat expandable graphite particles, a polymeric carrier, and an effective amount of a pigment that is capable of providing a coating that has an initial energy efficiency rating greater than or equal to 0.65 for a low-sloped roof, or an initial energy efficiency greater than or equal to 0.25 for a steep-sloped roof, wherein said mixture has a solids content from about 50-75 % of which 1-10 wt. % is said expandable graphite particles.

[0014] The present invention is also related to the film, i.e., top coat, that is formed from the top coating composition of the present invention as well as roofing products that are coated with the same.

Detailed Description of the Invention

[0015] As indicated above, the present invention provides a top coating composition for roofing products that provides durable exterior protection, superior fire resistance, and is highly reflective to solar energy. The highly reflective nature of the top coating composition of the present invention can provide a solar reflective coating that minimizes energy expended in air conditioning and levels temperature within a building structure.

[0016] The coating composition of the present invention includes a mixture of a polymeric binder, heat expandable graphite particles, a polymeric carrier and an

effective amount of a pigment that is capable of providing a coating that has an initial energy efficiency rating greater than or equal to 0.65 for a low-sloped roof, or an initial energy efficiency greater than or equal to 0.25 for a steep-sloped roof.

[0017] The mixture of the present invention has a solids content from about 50-75 % of which 1-10 wt. % is the expandable graphite particles. More typically, the mixture has a solid contents from about 60 to about 70 %.

[0018] The polymeric binder employed in the present invention is any thermoplastic polymer or thermoplastic rubber that is capable of forming a film upon curing. The polymeric binders employed in the present invention are typically in latex form. Suitable polymeric binders employed in the top coating composition of the present invention include, but are not limited to: acrylic or methacrylic polymers or copolymers, epoxy resins, polyvinyl acetate resins and thermoplastic rubbers such as styrene-butadiene rubbers, styrene-butadiene-styrene rubbers, styrene-ethylene-butadiene-styrene (SEBS) rubbers, styrene isoprene styrene (SIS) rubbers, and styrene butadiene rubbers (SBR).

[0019] In some embodiments, thermoplastic polymers, especially acrylic polymers or copolymers are employed as the polymeric binder of the top coating composition of the present invention. In other embodiments, a thermoplastic rubber such as SEBS is employed as the polymeric binder.

[0020] The polymeric binder component of the inventive top coating composition is typically present in the resultant mixture in an amount from about 5 to about 60 wt.%; the actual amount is dependent on the type of binder (thermoplastic polymers are present in a higher amount than thermoplastic rubbers). For example, and when the polymeric binder is an acrylic polymer, the acrylic polymer is typically present in an amount from about 30 to about 50 wt. %, with an amount from about 32 to about 48 wt. % being more typical for acrylic polymers. When thermoplastic rubbers are employed as the polymeric

binder, the thermoplastic rubber is typically present in an amount from about 8 to about 18 wt. %, with an amount from about 10 to about 15 wt. % being more typical. The amounts of the various components specified herein are based on 100% of the total mixture.

[0021] The coating composition of the present invention also includes a polymeric carrier. The type of polymeric carrier employed in the present invention is dependent on the type of polymeric binder used. For thermoplastic polymers, the polymeric carrier is typically water. When thermoplastic rubbers are employed as the polymeric binder, the polymeric carrier is a hydrocarbon solvent such as naphthanol, mineral spirits, ketones, naphthas and the like. The polymeric carrier is present in the inventive top coating composition in an amount from about 2 to about 40 wt. %, with an amount from about 6 to about 25 wt. % being more typical for thermoplastic polymers and rubbers.

[0022] The heat expandable graphite particles employed in the present invention impart fire-resistance characteristics to the resultant coating. Heat expandable graphite is formed by treating crystalline graphite, which is composed of stacks of parallel planes of carbon atoms, with intercalants such as sulfuric acid and/or nitric acid. Since no covalent bonding exists between the planes of the carbon atoms, the intercalant can be inserted therebetween. This allows the intercalant to be positioned within the graphite lattice. When the intercalated graphite is exposed to heat or flame, the inserted molecules decompose and release gases. The graphite layer planes are forced apart by the gas and the graphite expands, thereby creating a low-density, non-burnable, thermal insulation that can reflect a high percentage of heat.

[0023] The heat expandable graphite particles used in the present invention exhibit effective flame retardant properties and significantly reduce the smoke density and the self-extinguishing time of the polymeric binders without adversely effecting the physical properties of the coating compositions. The heat expandable graphite particles have "onset" temperatures from about 160°C to about 230°C. The particles undergo dramatic

expansion upon exposure to heat and flame. More particularly, the volume of the particles can increase to greater than 80 times their original volume in just a few seconds.

[0024] An example of expandable graphite particles that can be used in the present invention is GraftGuard™ Grade 220-80N. In some embodiments, the neutral graphite (designated by N) can be replaced with a basic graphite. This intumescent material is a graphite flake that begins to show significant expansion from 180° to 230°C. Because of its high on-set temperature, the preferred expandable graphite material can be used in applications where processing temperatures may reach 210°C. The particle size of the preferred expandable graphite particles employed in the present invention is from about 130 to about 320 microns.

[0025] The heat expandable graphite particles are typically present in the resultant mixture in an amount from about 1 to about 10 wt. %, with an amount from about 4 to about 8 wt. % being more typical. The amount of graphite particles is based on the total solids content of the inventive mixture.

[0026] The other component of the inventive top coating composition is a pigment. The pigment employed in the present invention can be any pigment that is capable of providing a highly reflective coating after the resultant mixture is cured. Typically, the pigment provides a coating that is white in color. Various shades of white are also possible as well as other colors that are capable of providing a coating that is highly reflective.

[0027] Suitable pigments that can be employed in the present invention include, but are not limited to: titanium dioxide, calcium carbonate, colemanite, aluminum trihydride (ATH), borate compounds, and mixtures thereof. One highly preferred pigment employed in the present top coating composition is titanium dioxide.

[0028] The pigments are employed in an amount that is efficient for providing a top coat that has an initial energy efficiency rating greater than or equal to 0.65 for a low-sloped roof, or an initial energy efficiency greater than or equal to 0.25 for a steep-sloped roof. The reflectivity provided by the inventive top coating composition, which is dependent on the degree of sloping of the roofing product, meets today's Energy Star® standards.

[0029] The pigments are typically present in the resultant mixture in an amount from about 2 to about 20 wt. %, with an amount from about 5 to about 15 wt. % being more typical for one of the aforementioned pigments. Note that fillers have a higher concentration than do the pigments used in the present invention.

[0030] The energy efficiency of the coating is determined by measuring its initial solar reflectance using ASTM E 903 (Standard test method for solar absorptance, reflectance, and transmission of materials using integrating spheres). Alternatively, the initial solar reflectance can be determined by ASTM C 1549 (Standard test method for determination of solar reflectance near ambient temperature using a portable reflectometer).

[0031] In addition to having the aforementioned initial solar reflectance values, the coating of the present invention needs to be capable of maintaining a solar reflectance for three years after installation on a low-sloped roof under normal conditions of greater than or equal to 0.50 (measured from the first year after installation). For steep-sloped roofing products, the top coating of the present invention has to maintain a solar reflectance for three years after installation under normal conditions of greater than or equal to 0.15 (measured from the first year after installation).

[0032] Maintenance of solar reflectance of a roofing product can be determined using the current guidelines mentioned in the Energy Star® program requirements

manual. The test can be carried out using ASTM E 1918 or ASTM C 1549 for low-sloped roofing products. ASTM C 1549 can be used in the case of steep-sloped roofing.

[0033] The coating composition of the present invention, which comprises a mixture of at least the above-mentioned components, may also include other optional components that are typically employed in top coating compositions. For example, the coating composition of the present invention can include any of the following components:

- dispersants such as potassium triphosphate, acrylic polymers or copolymers, and the like;

- defoamers that are capable of preventing foaming;

- fillers such as calcium carbonate, talc, white sand and the like;

- solvents that are capable of serving as a coalescing agent such as ethylene glycol, propylene glycol, alcohols, and the like;

- microbiocides that serve as fungicides, e.g., zinc oxide;

- thickening agents such as hydroxethyl cellulose, polyurethane, and the like;

- additional fire retardants such as alumina trihydrate, zinc borate, alkali metal silicates, and the like;

- pH modifiers such as aqueous ammonia;

- wetting agents such as siloxanes;

-light stabilizers such as hindered amines; and/or

-adhesion promoters such as hydrocarbon resins.

[0034] The optional components mentioned above are present in the coating composition of the present invention in amounts that are well known to those skilled in the art. The optional components are typically present in the mixture prior to the addition of the expandable graphite particles.

[0035] The coating composition of the present invention is prepared by first providing a mixture of at least the polymeric binder, the polymeric carrier, the pigment and the other optional ingredients and then adding the expandable graphite particles thereto while maintaining constant mixing. The addition of the expandable graphite particles typically occurs at nominal room temperature (20°C-40°C). Alternatively, the addition can occur at temperatures above nominal room temperature provided that the addition temperature does not exceed the on-set temperature of the expandable graphite particles. Mixing occurs using any mixing apparatus that can operate under low sheer conditions. By “low sheer” it is meant a mixing speed of about 60 rpm or less, which speed is capable of providing and maintaining a homogeneous mixture.

[0036] The mixing provides a blend (or emulsion) of components that can be applied immediately to a surface of a building materials product or the resultant mixture can be stored for several weeks or month prior to application.

[0037] The resultant top coating composition of the present invention can be applied to any substrate, especially roofing products or other related building materials products, by brushing, roller coating, spray coating, dip coating, squeegee and other like coating procedures. After applying the coating composition of the present invention to a surface of a substrate, the coating composition is cured at the temperature of the environment in which the coated substrate is located. Curing can take place in just a few minutes or

longer depending on the thickness of the applied coating as well as the environmental temperature.

[0038] The coating composition of the present invention is generally applied to the exterior surface of a substrate. In particular, the coating composition is generally applied to an expose exterior surface of a roofing product including low-sloped roofing products such as single ply membranes, built-up roofing (BUR), modified bitumen, ethylene propylene diene monomer (EPDM) rubber and standing-seam profile metal roofing, or steep sloped roofing products such as composite shingles, clay, concentrate, fiber cement tile, slate, shakes, architectural profiled metal and individual roofing components. In some preferred applications, the coating composition of the present invention is applied to BUR surfaces, modified bitumen and EPDM rubber

[0039] After application and curing, a top coat is provided to the substrate that provides durable protection to the substrate from abrasion, impact, water, and other environmental factors. Moreover, the top coat provided by the present invention is capable of extending the lifetime of the current roofing system. The top coat provided in the present invention is also breathable meaning that it has excellent porosity which allows for venting of vapors. Another characteristic of the coating formed from the top coating composition is that the resultant top coat has superior fire retardant capabilities. When introduced to flame (fire), it has the ability to char, allowing the intumescenting agent, namely graphite to expand, encompass the flame and further retard and prevent it from progressing further. Hence, the expanded graphite provides flame retardation by limiting the amount of oxygen present to the fire.

[0040] In addition to the foregoing properties, the top coat that is formed using the inventive composition has a high reflectivity that meets and even may exceed current Energy Star® values.

[0041] The following tables illustrate four exemplary coating compositions of the present invention which provide durable exterior protection to a surface in which they are applied. The exemplary coating compositions of the present invention also exhibit superior fire-resistance and are highly reflective meeting today's Energy Star® criteria. Coating Compositions A-D are made by first providing an emulsion that includes each of the named ingredients minus the GrafGuard® 220-80N (expandable graphite flakes). The GrafGuard® 220-80N is then added as described above and the admixture is stirred to provide a coating composition of the present invention. Coating compositions A, B and D include an aqueous acrylic-based emulsion and GrafGuard® 220-80N, while coating composition B includes a solvent-thermoplastic rubber-based emulsion and GrafGuard® 220-80N.

Table 1: Coating Composition A

Component/used as	% Range
Water/polymeric carrier	23.5-28.8
Potassium tripolyphosphate/dispersant	0.12-0.14
Acrylic polymer/dispersant	0.15-0.19
Defoamer/foam protection	0.34-0.42
Acrylic emulsion/binder	30.3-37.1
Calcium Carbonate/pigment	20.5- 25.1
Titanium dioxide/pigment	9.3-11.4
Alcoholic solvent/coalescing agent	0.6-0.74
Microbiocide/fungicide	0.14-0.17
Ethylene Glycol /coalescing agent	1.4-1.7
Hydroxyethyl cellulose/thickener	0.28-0.34
Graphite flake/fire retardant	3.2-4.0

Table 2: Coating Composition B

Component/used as	%
water/polymeric carrier	9.1-11.1
Potassium tripolyphosphate/dispersant	0.21-0.25
Acrylic polymer/dispersant	0.21-0.25
Defoamer/foam protection	0.4-0.5
Thickener/additive	0.17-0.21
Acrylic emulsion/binder	41.4-50.6
Titanium dioxide/pigment	5.0-6.0
Aluminum trihydrate/fire retardant	25.0-30.6
Zinc borate/fire retardant	2.1-2.5
Zinc oxide/fungicide	0.41-0.50
Aqueous ammonia/pH modifier	0.12-0.14
Polydimethyl siloxane/wetting agent	0.17-0.21
Alcoholic solvent/coalescing agent	1.65-2.01
Polyurethane/thickener	0.36-0.44
Microbiocide/fungicide	0.23-0.29
Graphite flake/fire retardant	3.93-4.81

Table 3: Coating Composition C

Component /used as	%
Napthol/polymeric carrier	7.5-9.1
Naptha/polymeric carrier	22.4-25.0
Hindered amine/light stabilizer	0.66-0.8

Defoamer/prevents foaming	0.66-0.8
Copolymer/dispersant	1.7-2.1
Titanium dioxide/pigment	11.5-14.0
Aluminum trihydrate/fire retardant	21.9-26.8
Hydrocarbon resin/adhesion promoter	3.0-3.7
Hydrocarbon resin/adhesion promoter	7.0-8.5
Thermoplastic rubber (SEBS)/polymeric binder	10.0-12.2
Graphite flake/fire retardant	3.9-4.7

Table 4: Coating Composition D

Description/used as	%
Water/polymeric carrier	10.8-13.2
Potassium tripolyphosphate/dispersant	0.1-0.12
Acrylic polymer/dispersant	0.34-0.42
Defoamer/foam protection	0.27-0.33
Acrylic emulsion/binder	29.8-36.4
Calcium Carbonate/pigment	30.0-36.6
Titanium dioxide/pigment	5.0-6.1
Zinc Oxide/fungicide	3.33-4.07
Alcoholic solvent/coalescing agent	0.5-0.61
Microbiocide/fungicide	0.15-0.19
Aqueous ammonia/pH modifier	0.07-0.09

Propylene glycol/coalescing agent	1.73-2.11
Hydroxyethyl cellulose/thickener	0.3-0.36
Graphite flake/fire retardant	4.02-4.92

Table 4: UL Burn Data

Class A: 2":12"	Deck - 4" ISO, EverGuard EPDM FR MA, Surface Seal SB FR (1.5g/sq - 1742grams)	TEST 3: w/ batten bar, membrane caught at 41 secs, total burn 4 1/2'...Passed 1 1/2":12" Class A...grandfathered 2":12" Class A.
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[0042] The above data is from UL (underwriters labs) test results on an intumescent coating of the present invention. The data shows that the coating provided enough fire resistance to obtain a class A rating on an EPDM substrate. Current reflectivity on this coating is 73 %.

[0043] While the present invention has been particularly shown and described with respect to preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing and other changes in forms and details may be made without departing from the spirit and scope of the present invention. It is therefore intended that the present invention not be limited to the exact forms and details described and illustrated, but fall within the scope of the appended claims.